

CLAIMS

What is claimed is:

1. A curable, powder-based coating composition for coating a substrate, having a first color effect, with a film layer wherein application of the film layer to the substrate produces a second color effect different from the first color effect of the substrate, said powder-based coating composition comprising:

(A) a powder-based binder comprising the reaction product of;

(I) a resin having a functional group, and

(II) a cross-linking agent reactive with said functional group of said resin; and

(B) a color effect-providing pigment comprising;

(I) a pigment substrate having first and second substantially parallel and planar surfaces, and

(II) an inorganic coating disposed on at least one of said first and second substantially parallel and planar surfaces of said pigment substrate (B)(I), said inorganic coating (B)(II) having an index of refraction of 1.8 or less;

wherein said inorganic coating (B)(II) and said pigment substrate (B)(I) of said color effect-providing pigment (B) interact with the first color effect of the substrate to produce the second color effect upon application of the film layer of the powder-based coating composition to the substrate.

2. A powder-based coating composition as set forth in claim 1 wherein said color effect-providing pigment (B) further comprises a reflective, absorbing coating (B)(III) which is at least partially transparent to visible light.

3. A powder-based coating composition as set forth in claim 2 wherein said reflective, absorbing coating (B)(III) comprises a selectively absorbing metal oxide.

4. A powder-based coating composition as set forth in claim 2 wherein said reflective, absorbing coating (B)(III) comprises a non-selectively absorbing metal.

5. A powder-based coating composition as set forth in claim 2 wherein said reflective, absorbing coating (B)(III) is disposed on said inorganic coating (B)(II).

6. A powder-based coating composition as set forth in claim 5 wherein said color effect-providing pigment (B) further comprises an outer coating (B)(IV) disposed on said reflective, absorbing coating (B)(III).

10 7. A powder-based coating composition as set forth in claim 6 wherein said outer coating (B)(IV) is different from said reflective, absorbing coating (B)(III) and comprises a selectively absorbing metal oxide.

15 8. A powder-based coating composition as set forth in claim 1 wherein said pigment substrate (B)(I) of said color effect-providing pigment (B) is selected from the group consisting of metallic pigment substrates, non-metallic pigment substrates, and combinations thereof.

9. A powder-based coating composition as set forth in claim 1 wherein said pigment substrate (B)(I) of said color effect-providing pigment (B) is further defined as a platelet-shaped pigment substrate.

20 10. A powder-based coating composition as set forth in claim 1 wherein said color effect-providing pigment (B) has a multilayer interference structure that is symmetrical.

11. A powder-based coating composition as set forth in claim 1 wherein said inorganic coating (B)(II) of said color effect-providing pigment (B) comprises a metal oxide.

12. A powder-based coating composition as set forth in claim 1 wherein said inorganic coating (B)(II) of said color effect-providing pigment (B) is selected from the group consisting of metal oxides, magnesium fluoride, and combinations thereof.

13. A powder-based coating composition as set forth in claim 1 wherein said inorganic coating (B)(II) of said color effect-providing pigment (B) is selected from the group consisting of silicon oxide, silicon oxide hydrate, aluminum oxide, aluminum oxide hydrate, titanium oxide, titanium oxide hydrate, zinc sulfide, magnesium fluoride, and combinations thereof.

14. A powder-based coating composition as set forth in claim 1 wherein said pigment substrate (B)(I) is a metallic pigment substrate.

15. A powder-based coating composition as set forth in claim 14 wherein said metallic pigment substrate is aluminum.

16. A powder-based coating composition as set forth in claim 15 wherein said aluminum pigment substrate has an average particle size of from 5 to 50 μm .

17. A powder-based coating composition as set forth in claim 15 wherein said aluminum pigment substrate has a particle size distribution where 50% of said aluminum pigment substrate has a particle size of from 13 to 16 μm and where no more than 5% of said aluminum pigment substrate has a particle size of greater than 50 μm .

18. A powder-based coating composition as set forth in claim 15 wherein said inorganic coating (B)(II) disposed on said aluminum pigment substrate comprises a metal oxide.

19. A powder-based coating composition as set forth in claim 15 wherein said 5 inorganic coating (B)(II) disposed on said aluminum pigment substrate is selected from the group consisting of silicon oxide, silicon oxide hydrate, aluminum oxide, aluminum oxide hydrate, and combinations thereof.

20. A powder-based coating composition as set forth in claim 15 wherein said inorganic coating (B)(II) disposed on said aluminum pigment substrate has a thickness of 10 from 200 to 600 nm.

21. A powder-based coating composition as set forth in claim 15 wherein said color effect-providing pigment (B) further comprises a reflective, selectively absorbing metal oxide disposed on said inorganic coating (B)(II) wherein said reflective, selectively absorbing metal oxide has an index of refraction of 2.0 or greater and is at least partially 15 transparent to visible light.

22. A powder-based coating composition as set forth in claim 21 wherein said color effect-providing pigment (B) further comprises an absorbing, outer coating different from and disposed on said reflective, selectively absorbing metal oxide.

23. A powder-based coating composition as set forth in claim 22 wherein said 20 absorbing, outer coating is selected from the group of selectively absorbing oxides consisting of iron (III) oxide, chromium (III) oxide, vanadium (V) oxide, titanium (III) oxide, and combinations thereof.

24. A powder-based coating composition as set forth in claim 22 wherein said absorbing, outer coating is selected from the group of non-selectively absorbing oxides consisting of titanium dioxide, zirconium oxide, and combinations thereof.

25. A powder-based coating composition as set forth in claim 14 wherein said 5 metallic pigment substrate is selected from the group consisting of chromium, nickel, and combinations thereof.

26. A powder-based coating composition as set forth in claim 25 wherein said color effect-providing pigment (B) has an average particle size of from 5 to 40 μm .

27. A powder-based coating composition as set forth in claim 25 wherein said 10 color effect-providing pigment (B) has a particle size distribution where no more than 10% of said pigment (B) has a particle size of greater than 50 μm and substantially none of said pigment (B) has a particle size of greater than 125 μm .

28. A powder-based coating composition as set forth in claim 25 wherein said 15 inorganic coating (B)(II) disposed on said metallic pigment substrate is a dielectric inorganic coating having an index of refraction of 1.65 or less.

29. A powder-based coating composition as set forth in claim 25 wherein said inorganic coating (B)(II) disposed on said metallic pigment substrate is selected from the group consisting of silicon oxide, silicon oxide hydrate, aluminum oxide, aluminum oxide hydrate, magnesium fluoride, and combinations thereof.

30. A powder-based coating composition as set forth in claim 25 wherein said 20 color effect-providing pigment (B) further comprises a semi-transparent metal coating disposed on said inorganic coating (B)(II) wherein said semi-transparent metal coating comprises aluminum.

31. A powder-based coating composition as set forth in claim 25 wherein said color effect-providing pigment (B) further comprises a semi-transparent metal coating disposed on said inorganic coating (B)(II) wherein said semi-transparent metal coating is selected from the group consisting of aluminum, gold, copper, silver, and combinations thereof.

5 32. A powder-based coating composition as set forth in claim 14 wherein said metallic pigment substrate is steel.

33. A powder-based coating composition as set forth in claim 32 wherein said steel pigment substrate is stainless steel.

10 34. A powder-based coating composition as set forth in claim 32 wherein said steel pigment substrate is an alloy of steel having from 1 to 30 parts by weight of chromium based on 100 parts by weight of said alloy of steel.

35. A powder-based coating composition as set forth in claim 14 wherein said metallic pigment substrate is selected from the group consisting of aluminum, chromium, 15 nickel, steel, stainless steel, and combinations thereof.

36. A powder-based coating composition as set forth in claim 1 wherein said pigment substrate (B)(I) is a non-metallic pigment substrate.

37. A powder-based coating composition as set forth in claim 36 wherein said non-metallic pigment substrate has an index of refraction 2.0 or greater.

20 38. A powder-based coating composition as set forth in claim 36 wherein said non-metallic pigment substrate is iron oxide.

39. A powder-based coating composition as set forth in claim 36 wherein said non-metallic pigment substrate is mica having an oxide coating.

40. A powder-based coating composition as set forth in claim 39 wherein said oxide coating is further defined as a TiO_2 coating having a thickness of from 10 to 300 nm.

41. A powder-based coating composition as set forth in claim 36 wherein said 5 non-metallic pigment substrate is selected from the group of substrates consisting of iron oxide, mica having an oxide coating, and combinations thereof.

42. A powder-based coating composition as set forth in claim 41 wherein said non-metallic pigment substrate has an average particle size of from 5 to 50 μm .

43. A powder-based coating composition as set forth in claim 41 wherein said 10 inorganic coating (B)(II) disposed on said non-metallic pigment substrate is selected from the group consisting of metal oxides, magnesium fluoride, and combinations thereof.

44. A powder-based coating composition as set forth in claim 41 wherein said 15 inorganic coating (B)(II) disposed on said non-metallic pigment substrate is selected from the group consisting of silicon oxide, silicon oxide hydrate, aluminum oxide, aluminum oxide hydrate, and combinations thereof.

45. A powder-based coating composition as set forth in claim 41 wherein said inorganic coating (B)(II) disposed on said non-metallic pigment substrate has a thickness of from 20 to 800 nm.

20 46. A powder-based coating composition as set forth in claim 41 wherein said color effect-providing pigment (B) further comprises a reflective, absorbing coating disposed on said inorganic coating (B)(II) wherein said reflective, absorbing coating is

selected from the group consisting of metals, metal oxides, metal sulfides, metal nitrides, and combinations thereof.

47. A powder-based coating composition as set forth in claim 41 wherein said color effect-providing pigment (B) further comprises a reflective, absorbing coating disposed on said inorganic coating (B)(II) wherein said reflective, absorbing coating has a thickness of from 1 to 500 nm.

48. A powder-based coating composition as set forth in claim 47 wherein said color effect-providing pigment (B) further comprises an absorbing, outer coating different from and disposed on said reflective, absorbing coating.

10 49. A powder-based coating composition as set forth in claim 48 wherein said absorbing, outer coating comprises a metal oxide.

50. A powder-based coating composition as set forth in claim 48 wherein said absorbing, outer coating is selected from the group consisting of silicon oxide, silicon oxide hydrate, aluminum oxide, aluminum oxide hydrate, tin oxide, titanium dioxide, 15 zirconium oxide, iron (III) oxide, chromium (III) oxide, and combinations thereof.

51. A powder-based coating composition as set forth in claim 1 wherein said resin (A)(I) of said powder-based binder (A) is selected from the group consisting of acrylic resins, epoxy resins, phenolic resins, polyester resins, urethane resins, and combinations thereof.

20 52. A powder-based coating composition as set forth in claim 1 wherein said functional group of said resin (A)(I) is selected from the group consisting of epoxy functional groups, carboxy functional groups, hydroxy functional groups, and combinations thereof.

53. A powder-based coating composition as set forth in claim 1 wherein said cross-linking agent (A)(II) of said powder-based binder (A) is selected from the group consisting of aminoplasts, blocked isocyanates, polycarboxylic acids, acid anhydrides, polyamines, and combinations thereof.

5 54. A substrate having at least one surface that has been coated with the powder-based coating composition as set forth in claim 1.

55. A method of coating a substrate to produce the second color effect upon application of the film layer of the powder-based coating composition to the substrate, said method characterized by using the powder-based coating composition as set forth in 10 claim 1.

56. A powder-based coating composition as set forth in claim 1 wherein said inorganic coating (B)(II) and said pigment substrate (B)(I) of said color effect-providing pigment (B) interact with the first color effect of the substrate such that the second color effect is different from the first color effect at least by ΔL 20.0, Δa 10.0, and Δb 15.0 as 15 measured according to CIELab color space.

57. A powder-based coating composition as set forth in claim 1 wherein said coating composition is a powder clearcoat applied on the substrate to produce the second color effect.

58. A powder-based coating composition as set forth in claim 1 wherein the 20 interaction of said inorganic coating (B)(II) and said pigment substrate (B)(I) with the first color effect of the substrate to produce the second color effect is further defined as interference of light waves that establishes angle-dependent color and lightness effects to achieve the second color effect.

59. A powder-based coating composition as set forth in claim 1 wherein the interaction of said inorganic coating (B)(II) and said pigment substrate (B)(I) with the first color effect of the substrate to produce the second color effect is further defined as absorption of light waves that establishes angle-dependent color and lightness effects to 5 achieve the second color effect.

60. A powder-based coating composition as set forth in claim 1 wherein the interaction of said inorganic coating (B)(II) and said pigment substrate (B)(I) with the first color effect of the substrate to produce the second color effect is further defined as reflection of light waves that establishes angle-dependent color and lightness effects to achieve the second color effect.

61. A powder-based coating composition as set forth in claim 1 comprising from 0.1 to 10 parts by weight of said color effect providing pigment (B) based on 100 parts by weight of said powder-based binder (A).